1.0 Introduction

This document describes travel time and speed data, collected by the consulting firm PBS&J, for Parsons Brinckerhoff (PB) and the Atlanta Regional Commission (ARC) during the fall of 2001. The data collection effort was a task specified in a master contract between the ARC and PB for consulting services pertaining to travel demand model refinements. PBS&J's role was to collect the data while PB developed the sample design. In addition, PB will eventually use the travel time and speed data to update and make refinements to the ARC's regional travel demand model. The data may also be used by PB, the ARC or others to refine parameters used in estimating motor vehicle emissions.

A total of 63 routes were identified by PB to provide the framework for data collection. Route locations and lengths are depicted in map form on the next page. PBS&J performed the data collection between September 10, 2001 and November 9, 2001 which included the week that terrorists attacked the United States in New York City and Washington, D.C.. The routes covered regions across the metro area – as far south as US 19/41 in Hampton, and as far north as GA 20 in Cumming. The types of roadways included in the routes also varied widely from two-lane collector streets to freeways. In addition, the roadways and routes in the sample were selected so that different area types would be reflected in the data. Area types identify the types or combinations of land uses that surround a particular section of road. These include rural, suburban, urban, residential and commercial characteristics.

Preliminary findings from the travel time and speed data collection effort are presented herein. The preliminary data analyses and findings are broken into three types of data sets:

1) Individual sample route statistics including date, start time, direction of travel, travel time and average speed for each observation;
2) Group route statistics including the average travel time, standard deviation of travel time and average speed by time-of-day period and direction of travel; and
3) Group segment statistics which includes the average travel speed for highway network links in the same facility type and area type stratification.

Regional Route Map

2.0 Sampling Plan

The ARC sought "real" travel time and average speed to validate and refine their travel demand model, as well as to make refinements to speed tables that are used in estimating motor vehicle emissions if deemed appropriate. By the term "real", it is meant that the ARC was looking for travel time and speed data of current vintage and based on time/speed observations that were accurately recorded by field instruments on the routes themselves. In response to these specifications, PB developed a sample design for the travel time and speed data collection effort to obtain the following statistics:

- Average travel times for specified routes by time-of-day period and direction of travel; and,
- Average travel speeds by Facility Type and Area Type codes.

Facility and area type codes are standard attributes of a highway network file used in the travel demand modeling process. In the ARC model, both link speeds and capacities are based on the facility type and area type codes.

2.1 Routes

A total of 63 routes were identified by PB for inclusion in the travel time and speed data collection effort. They were selected geographically so that the sample would cover the entire region. They should be well known routes frequently used by motorists in metropolitan Atlanta, especially by commuters. Moreover, they were chosen to represent sections of road containing a broad spectrum of facility type and area type combinations with an emphasis on Freeways, Class I and Class II arterials. The routes, grouped by freeway and non-freeway type facilities, are listed in a table on the following page. Individual maps highlighting the routes that were driven during the data collection process are included in the section of this document containing route-level findings.

2.2 Methodology

It was envisioned that travel time and speed data would be collected by means of drivers who would drive their cars (repeatedly) back and forth over a sample route for two days. The data would actually be obtained by means of a GPS unit and data storage device. One of the advantages of this technique is that only a single person needs to be driving the route collecting data. Most importantly, the single person is the driver who is able to focus on safe driving while collecting data on a route. Drivers of the vehicles needed to: (1) sample the route using a *floating car* technique which means they drive slower than the fastest, but faster than the slowest; (2) make sure they stayed on the designated route assigned to them; and, (3) fill out a drivers log sheet after completing a sample of a route. For each sample run, drivers would check boxes pertaining to weather, light and pavement conditions as well as report incidents that may have affected the sample time or average speed. Drivers brought their loaded data collector devices into the central office after two days of driving a route or between collecting data for different routes.

Route List

STUDY ID	ROUTE NAME	APPROX. LENGTH	STUDY ID	ROUTE NAME	APPROX. LENGTH
FREEWAY ROUTES IN SAMPLE			NON-FREEWAY ROUTES IN SAMPLE (CONTINUED)		
1	I-575	19.52	29	Buford Dr (GA 20/124)	12.42
3	I-285/I-85	25.55	30	Cumming Hwy (GA 20)	15.32
13	I-20	14.26	31	Main St/Cumming Hwy (GA 20)	18.41
14	I-20	17.75	32	Duluth Hwy (GA 120)	12.59
16	I-285	13.12	33	Pleasant Hill/State Br Rd/Alpharetta Hwy	11.95
20	I-285E	16.90	34	Holcomb Bridge Rd/Jimmy Carter Blvd	12.51
23	I-75	17.28	35	Holcomb Bridge Rd/Woodstock Rd	12.50
40	I-85	20.47	36	Woodstock Rd	10.76
45	GA 400	29.96	37	Jimmy Carter Blvd	13.70
49	I-75 (north)	20.09	38	Crabapple Rd/Roswell Rd (GA 9)	13.47
NON-FREEWAY ROUTES IN SAMPLE			39	Marietta Pkwy/Roswell Rd (GA120)	10.34
2	Tara Blvd(US 19/41 & GA3)	14.58	41	Redan/Deshon Rd	10.40
4	Jonesboro Rd(GA 138)	14.64	42	Memorial Drive	12.07
5	N Henry Stockbridge(US23 & GA138)	15.05	43	Memorial/MLK Drive	13.15
6	Jonesboro Rd (GA 54/3)	14.20	44	Cascade Road	10.10
7	Forest Rd/Panola Rd	16.10	46	Main St/Roosevelt Hwy	12.00
8	Fairburn Rd (GA 92/166)	15.90	47	Herschel Rd/Old National Hwy	11.55
9	Langford Mem. Hwy (GA 166)	16.09	48	Riverdale Rd	14.79
10	Camp Creek Pkwy/ Thornton (GA 6)	15.55	50	Upper Riverdale/Old Dixie/Browns Mill Rd	11.26
11	Thornton Rd (US 278/GA 6)	12.65	51	Marietta Blvd/Cooper Lake Rd	12.90
12	Fulton Ind. Blvd (GA 70)	13.24	52	Mount Vernon Rd/Spalding Rd	13.43
15	Dogwood/Metropolitan (GA 3)	13.87	53	Johnson Ferry/Childers/Jones Rd	12.20
17	Flat Shoals Pkwy/Hairston/Scott Hwy	13.39	54	Barrett Pkwy/Post Oak/Tritt/Willeo Rd	13.08
18	Veteran Mem. Hwy (US 278/78)	14.58	55	Shallowford Rd/Pine Rd	10.15
19	South Cobb Dr (GA 280)	14.23	56	Windy Hill/Terrell Mill/Old Canton/Holly Spr	12.53
21	Ponce De leon Ave	14.13	57	Dallas Rd/Whitlock/Roswell/ Paper Mill Rd	12.32
22	Covington Hwy (US 278/GA 12)	13.20	58	Old Alabama/Jones Bridge/McFarland Rd	14.43
24	North Decatur Rd/Rockbridge Rd	13.36	59	Lawrenceville-Suwanee/Suwanee Dam Rd	14.53
25	Five Forks	12.75	60	Old Norcross Rd	12.81
26	Lawrencevile Rd/Lavista Rd (GA 236)	13.60	61	Killian Hill/Indian Trail/Bethany Church Rd	14.60
27	Pleasant Hill Rd	11.82	62	Rockbridge Rd/Rockbridge Dr	11.05
28	Flat Shoals Pkwy/Bouldercrest Rd	11.33	63	Wesley Chapel/Flakes Mill/Fairview Rd	13.66

The GPS unit obtained the driver's position from satellite signals as well as the clock time during every second that a driver was out in the field. The vendor of the GPS units supplied software to download the logged points and times from the data recording device onto a desktop personal computer. PBS&J, then, developed a software application that would convert the amassed logged point files containing one or two days of data into individual route files containing only those points belonging to an individual sample.

Other advantages of employing the GPS technique are accuracy, consistency and quality control. In terms of accuracy and consistency, the GPS receiver records the position of the driver's vehicle to within 15-meters using the GeoStats GeoLogger unit. Along with Lat-Long coordinates, the receiver simultaneously records clock time every second. With this type of data, accurate and consistent travel times and average speeds for route and segment samples were obtained by splitting data in the GPS point (log) files using control points representing the position of beginning and end points of the routes as well as beginning and end points of the sample segments inside each route. For quality control, the GPS-based log files allow the data collection to plot partially processed routes to ensure that drivers were, indeed, driving the designated routes without any interruptions during a sample run. The study team was also able to obtain spot speed data on the routes based on the positional changes of a vehicle along a route using this technology.

2.3 Time Frame

The original time frame for collecting the data included all weekdays during the four week period from Monday, September 10th to Friday, October 5th. There were, however, a couple exceptions. Data was not collected on Monday mornings or Friday afternoons because irregular travel patterns often occur during these particular time periods. Nor was it collected on Columbus Day, which was celebrated on Monday, October 8th. Drivers were out collecting data during the week that international terrorists attacked the World Trade Center in New York City and the Pentagon Building in Washington, D.C., . Not a lot of data was collected at that time because it was the first week that drivers were sent into the field and PBS&J was still in the early stages of recruiting drivers.

It was anticipated that an individual driver or driver team would collect samples on a particular route from 6:00 A.M. to 7:00 P.M. over the course of two weekdays. A single driver could do the entire day with a rest period in the middle of the day, or a team approach using one driver for the morning and a second driver for the afternoon could be employed.

Three time-of-day periods were identified in the sample design for purposes of organizing and managing the data collected in the field. These were:

- AM Peak Period - 6:00 AM to 9:30 AM;
- Off-Peak Period - 9:30 AM to 4:00 PM; and
- PM Peak Period - 4:00 PM to 7:00 PM.

3.0 Data Collection

Elite Staffing Services, located in Atlanta, was used to supply PBS&J with drivers whose job was to drive their motor vehicle back and forth over the routes. At the peak staffing level, there were 9 full-time drivers and 1 part-time driver. A full-time driver could perform all of the sampling needed on two routes during a week. A part-time driver could only do one sample per week. At the peak staffing level for drivers, full data sets could be obtained from 19 routes during a one week period under ideal conditions. With ideal conditions, the data collection could have been completed within the one month time frame that was assumed in the sample design.

Weather was never a problem. Atlanta experienced dry, sunny weather throughout the data collection effort. The data collection instruments, GeoStats' GeoLogger GPS units, performed accurately and consistently throughout the data collection effort. None of the drivers were involved in collisions during the survey effort which was fortunate considering how many miles were driven and that breakdowns resulting from excessive wear on brakes and tires were common. There were, however, a number of situations that transpired during the data collection process that extended the duration of collecting data. These are explained later in this section.

3.1 Procedures

<u>Driver Recruitment and Training</u>. Recruitment of drivers was more difficult than anticipated. PBS&J used one temporary employment agency to supply drivers. In hindsight, the data collection would have proceeded smoother and closer to schedule if two temporary employment firms had been contracted to provide drivers. There were five significant obstacles regarding the recruitment of drivers that made it difficult for the data collection effort to proceed at full speed: (1) Drivers needed to have or be able to rent a reliable car with good tires, brakes, heating/cooling system and a functional cigarette lighter; (2) Drivers needed to have valid drivers licences and proof of insurance; (3) The work hours were difficult for most drivers to sustain for more than one or two consecutive weeks; (4) Drivers needed to be able to navigate by means of reading a map; and, (5) Drivers needed to be in good health.

Due to the ease of operation with the GPS data collection instruments, there was minimal training required for the drivers. Nevertheless, drivers were given instructions explaining how to drive so their behavior would be consistent with the floating car method of collecting travel time and speed data. They were instructed regarding the importance of starting their samples by 6:30 AM for the morning shift and staying on the route to collect samples until 7:00 PM on the evening shift. They were informed that it was essential to finish a sample run before making any stops. This meant they were to take breaks, fill out driver sheets or rest between the end of one sample and the start of the next.

After drivers finished a sample run, they would record information about their trip on a driver form. This form included the route number and a list of highway facilities that comprised the route, begin time, end time, weather conditions, and a space to record any incidents that may have affected their travel time. These were used for two main purposes: (1) to monitor and keep track of the mileage and number of samples for each driver on a particular route; and, (2) as part of the quality control process for identification of defective sample runs due to unusual incidents occurring along the route.

PBS&J made route maps for the drivers and explained how to get to the beginning point or end point from their home or PBS&J's office. This particular aspect of working with the drivers proved more difficult than anticipated.

<u>GPS Data Receiver</u>. Data for each route was collected using the GeoLogger GPS unit from Geostats. This device is a passive GPS receiver; that is, the driver simply plugs the unit into the cigarette lighter in his vehicle and mounts the antenna onto the roof of the vehicle and the Geologger begins recording GPS data automatically. The data is recorded at one-second intervals and consists of information such as latitude/longitude position and time, as well as some other satellite and navigational information. After this data is processed, the vehicle speed can be calculated at any point along the route based on the position and time data.

<u>Data Download and Conversion</u>. The data collected and recorded on the GeoLoggers had to be downloaded and post-processed on a desktop PC after one or two days of use. Downloading 40,000 points from a data recorder was common. This would take approximately 15-20 minutes. The initial data file that came directly out of the GPS unit was in a comma-separated format that was not readily acceptable to GIS software . GeoStats provided a data conversion program that involved some preliminary processing and reformatting of the data to make the downloaded file readable to ArcInfo GIS software.

<u>Sample Split Program</u>. After the data was downloaded and converted to a GIS format, point/time records for individual sample runs were lumped together into a single large file with data that did not belong to legitimate sample runs. It was necessary, therefore, to have a post-processing software that read the large file and split it into individual files containing a single sample run for a particular route. Such a program was developed and runs based on a convergence process at each endpoint on the route. The endpoints consist of latitude/longitude coordinates as identified on the Georgia Department of Transportation's Street Centerline File GIS coverage. The possibility exists that either the driver did not extend his route all the way through the endpoint, or the GIS-based endpoint did not exactly coincide with the GPS-based route point. As a result, some adjustments had to be made to the endpoint control file in order to split the large data files into smaller files containing only those points and times corresponding to an individual sample run.

On a typical full day, the number of sample routes collected by a driver was about 40, with 20% in the AM period, 30% in the PM period, and the remaining 50% in the off-peak period. This number and distribution varied widely depending on the length of the route and the amount of congestion throughout the day.

<u>Initial Quality Control</u>. The first step in checking the quality of data was to plot selected sample runs on a map. In this way, it was possible to ensure that the drivers were staying on the designated route for each sample. While it was not feasible to plot each and every sample

run for each day on a route, it was determined that the first three to four samples of the day were critical in showing the "learning curve" of the driver finding the proper route. These samples were easily identified and removed from the data set. After this point, it was assumed that the driver would know the route well enough not to stray from the correct path.

Segment Split Program. A second program was developed and used to further process the individual sample runs on each route. This program read the sample file and split the route into segments defined by cross streets that had been coded into the ARC's highway network along the route. To do this, the latitude/longitude coordinates of the intersections were determined from a GIS base map. As the program read the recorded data points from the sample file, it determined where one segment ended and the next began.

This process was based on a convergence of points in the sample file around a segment control point. Consequently, another type of refinement was necessary for some routes. In some instances there were significant differences between the control points obtained from the street centerline file and the GPS-based sample route data. In fact, there were several routes where the program did not find convergence on certain intersections along the route. In these cases, a sample route was plotted against the intersection control points and the control points were adjusted as necessary to coincide with the GPS-recorded route. There was another reason why points in a sample run did not converge on an intersection. The GPS receiver was not always able to consistently record data. The receiver would lose contact with the satellite signals for a few moments because of overhead interference. This interference was mainly due to one of three situations: tree canopy, tall buildings, or bridge structures. A plot of the sample runs would reveal a small "hole" in the data, which occasionally happened to be at an intersection point. This gap around the intersection control points was often of sufficient size that the program was not able to converge on that point. In these instances, it was necessary to omit some control points and merge segments to make it possible to split the majority of samples on a particular route.

3.2 Quality Control Refinements

Unusable Data. There were several stages where quality control was incorporated into the data collection and refinement process. First, drivers' paths were displayed in GIS as soon as possible after turning in their data recorders to ensure they were collecting data on the designated route. Later, in the process of assembling and reviewing completed route samples, potential observations containing unusable points and times were discarded or flagged. Some of the reasons for unusable data included the following: incorrectly driven routes; detours within the route due to construction; accidents; stalls; auto breakdowns; and, detours within the route due to driver error (wrong turn, gas stop, restroom stop, etc.). In these instances, it was necessary to omit the entire sample from the data set since the route was not driven properly. These samples were identified in the initial segment split program, which would print out the GPS-calculated length of the route. Based on the known length of each route, any samples with a length outside an acceptable margin of error were identified as unacceptable data and discarded. The other critical point where erroneous samples were identified was during the route-level statistical analysis. By examining the GPS length field, the lengths of each sample should be consistent with a margin of error of about +/- 0.1 miles. This is the level of accuracy that can be expected from GPS data. Any sample runs exhibiting lengths outside that tolerance were dismissed from the data set prior to calculating group-level route statistics and flagged for subsequent removal in the segment-level calculations. The amount of data discarded in this stage, however, was minimal since most of the bad samples were previously identified in earlier steps.

Data Modifications. Due to road closures, detours, realignment, and unforeseen geometric obstructions on some of the roads in the sample, the path of some routes had to be modified slightly. These were instances where the driver made a conscious effort to drive the route as best he or she could, but the route driven was not the same as the one defined in the sample design. It was not feasible in these circumstances to dismiss an entire data set for such a route, so modifications were made to the control point files that were used to split the data into samples.

The most common occurrence was that of a driver inadvertently ending his route just a few blocks from the correct endpoint. This may have been necessary because the configuration of the intersection made it unreasonable to drive through and turn around within a reasonable distance. In these cases, the endpoint was either moved slightly to the turn-around location, or the endpoint was omitted and the route was shortened by one segment. The individual route and corresponding segment maps are included herein along with the listings of sample route data. Individual route modifications are described below.

Route 62 - is a special case where the route was significantly modified. The original route followed Rockbridge Road in Gwinnett County from Jimmy Carter Blvd. south to North Deshon Road and back onto South Rockbridge Road, terminating at Rockbridge Road. Two drivers drove this route at different times, and they both have different paths for the last one-fourth of the route, where one driver made the correct turn onto North Deshon Road, the other driver continued on Annistown Road. The signage and street alignments may have made it difficult for them to find the correct path. The endpoints were modified to the first three-quarters of the route so that we were able to keep the two days of data already recorded. In light of the resources that were already committed to drivers at this point in the project, it was decided that the route would be shortened as opposed to sampling it for another entire day.

Route 30 - is another case where two different paths were taken. The correct path is on State Route 20, Cumming Highway, from Peachtree Industrial Boulevard north to Bethelview Road northwest of Cumming. On the section just south of Cumming on Veterans Memorial Highway, the driver took two different routes on his northbound and southbound paths, as if it were a split one-way pair. The northbound path correctly follows Veterans Memorial Highway into Cumming; however, the southbound path follows State Route 9 back down to SR 20 near the GA 400 interchange. These two paths are different enough in facility type, that a one-way pair cannot be assumed. It was therefore necessary to keep two sets of data for Route 30. These are labeled as Route 30 for the correct path on Veterans Memorial Highway, and Route 30x for the southbound path on SR 9. Both paths for Route 30 are illustrated along with the listing of statistics for Route 30 samples.

3.3 Database Definition and Sample Size

Once data for each route was split and segmented, it was imported and stored in a single Microsoft Access database. The database was and should continue to be a useful tool for organizing and manipulating data collected in this study. ACCESS allows for easy calculations of basic statistical information and has relatively simple reporting capabilities. An ACCESS database table was created for each route containing all of the position/time data points that were associated with good sample runs. The number of records in a typical route table ranges between 40,000-60,000. An individual sample accounts for 800-1,200 point/time records inside of a route table. A description of the data fields included in these tables is presented in a dictionary table, presented below.

DATABASE DICTIONARY

FIELD NAME	DATA TYPE	CODES	DESCRIPTION
ID	Long Int.	None	Unique record identifier in database
REC_NUM	Long Int.	None	Record number key which matches record to original dataset collected by driver
FLAG	Text	'A'	GPS received satellite signals to mark position
		'V'	GPS *not* received satellite signals to mark position
DATE	Date	None	Date route was driven
TIME	Time	None	GPS clock time (hr:min:sec)
TIME_CODE	Int.	1	AM Period - Start sample between 6:00-9:30 AM
		2	Off-Peak Period - Start sample between 9:30 AM and 4:00 PM
		3	PM Period - Start sample between 4:00-7:00 PM
SEC	Long Int.	None	Number of seconds elapsed during collection of an individual GPS point stream
DELTASEC	Int.	None	Number of seconds elapsed without logging a point from the GPS signal
LONG	Double	None	Position of driver - Longitudinal Coordinate
LAT	Double	None	Position of driver - Latitudinal Coordinate
SPEED	Real	None	GPS calculated spot speed (mph) to 1 decimal place
HEAD	Int.	None	Compass heading of driver
HDOP	Real	None	GPS signal accuracy indicator
NOSATS	Int.	None	Number of satellites picked up to calculate driver's position
CNTRL_DIST	Double	None	Driver's distance to next control point
GPS_DIST	Double	None	GPS calculated distance from the previous position (i.e., usually 1 second before)
RTE_ID	Text	1-63	Route identification number
SAMPLE_ID	Text	None	Identification code used to reference all point records on a specific sample (combination of date & sample run number)
SEGMENT_ID	Int.	1-40	Identification code of segments on a route (In process of building segment maps & tables as we process the travel time data)
DIR_FLAG	Int.	1	Sample driven from begin control point to end control point
		2	Sample driven from end control point to begin control point

Once data, that appeared to be usable, was entered into the database tables the number of sample runs were counted by time-of-day. The preliminary count of good sample runs by route and time period is reported in a table that is displayed on the next page. A total of 2,817 samples were entered into database tables. Broken out by time period: 736 samples were begun during the AM period; 1,339 were started during the Off-Peak period; and, 742 begun during the PM period. The highest number of samples collected for an individual route was 90, on Route 1 (I-575). The fewest number of samples recorded for a route was 26. Routes with fewer than 30 samples included: Route 9 (Langford Mem. Hwy.); Route 30 (Cumming Hwy.); Route 32 (Duluth Hwy.); and, Route 57 (Dallas Rd./Whitlock/Roswell/Paper Mill).

At the initial stage of database development, quality control measures employed in splitting and segmenting data eliminated the vast majority of unusable data turned in by drivers. There were, however, a small number of additional samples counted in the table on the next page that were not included in the average speed calculations but were not removed from the database tables. These samples generated average speeds that did not fall within a reasonable range for a given time period and direction of travel. These are identified by route number and sample identification number in Appendix C.

The volume of mileage driven, just for the usable samples, is reported in the sample size table partitioned by freeway and non-freeway facilities and time period. It was calculated by taking the product of the "number of samples" and "route lengths" that were obtained from the ARC's highway network. A total of 38,148 miles were driven to obtain the sample data that was loaded into the route tables. If mileage accumulated by the drivers for other reasons were added to this total, the number of miles would exceed 50,000.

Sample Mileage

TIME PERIOD		MILEAGE
Freeways		
AM		3,091
Off-Peak		4,904
PM		2,580
Subtotal		10,575
Non-Freeways		
AM		7,533
Off-Peak		13,078
PM		6,962
Subtotal		27,573
Grand Total		38,148

A large amount of non-sample mileage was driven for several reasons. First, some drivers had a difficult time with directions and drove an incorrect route at times. Many samples that were driven did not make it into the database because they were biased by accidents, breakdowns, road construction or other types of incidents.

Sample Size

ROUTE ID	ROUTE NAME	NUMBER OF SAMPLES AM	OFF	PM	TOTAL
1	I-575	26	40	24	90
2	Tara Blvd (US 19/41 & GA 3)	13	21	10	44
3	I-285/I-85	15	19	7	41
4	Jonesboro Rd (GA 138)	10	19	10	39
5	N. Henry Stockbridge (US 23 & GA 138/42)	11	25	11	47
6	Jonesboro Rd (GA 54/3)	14	18	6	38
7	Forest Rd/Panola Rd	8	15	8	31
8	Fairburn Rd (GA 92/166)	13	31	7	51
9	Langford Mem. Hwy (GA 166)	5	16	5	26
10	Camp Creek Pkwy/ Thornton Camp (GA 6)	11	23	13	47
11	Thornton Rd (US 278/GA 6)	13	21	13	47
12	Fulton Ind. Blvd (GA 70)	15	13	17	45
13	I-20	25	36	20	81
14	I-20	10	15	14	39
15	Dogwood/Metropolitan (GA 3)	6	22	9	37
16	I-285	16	31	15	62
17	Flat Shoals Pkwy / Hairston / Scott Hwy	10	18	13	41
18	Veteran Mem. Hwy (US 278/78 & GA 8)	11	15	13	39
19	South Cobb Dr (GA 280)	11	26	10	47
20	I-285E	10	29	14	53
21	Ponce De leon Ave	8	14	9	31
22	Covington Hwy (US 278/GA 12)	12	15	8	35
23	I-75	14	11	8	33
24	North Decatur Rd/Rockbridge Rd	8	17	14	39
25	Five Forks	14	19	12	45
26	Lawrencevile Rd/Lavista Rd (GA 236)	12	17	9	38
27	Pleasant Hill Rd	10	10	17	37
28	Flat Shoals Pkwy/Bouldercrest Rd	13	16	17	46
29	Buford Dr (GA 20/124)	14	20	13	47
30	Cumming Hwy (GA 20)	6	15	5	26
31	Main St/Cumming Hwy (GA 20)	9	23	14	46
32	Duluth Hwy (GA 120)	8	9	10	27
33	Pleasant Hill/State Br Rd/Alpharetta Hwy	16	19	11	46
34	Holcomb Bridge Rd/Jimmy Carter Blvd	11	19	10	40
35	Holcomb Bridge Rd/Woodstock Rd	9	24	13	46
36	Woodstock Rd	8	23	9	40
37	Jimmy Carter Blvd	18	24	14	56
38	Crabapple Rd/Roswell Rd (GA 9)	14	11	5	30
39	Marietta Pkwy/Roswell Rd (GA120)	9	23	20	52
40	I-85	20	40	18	78
41	Redan/Deshon Rd	10	29	15	54
42	Memorial Drive	20	35	18	73
43	Memorial/MLK Drive	9	21	8	38
44	Cascade Road	14	29	15	58
45	GA 400	11	19	10	40
46	Main St/Roosevelt Hwy	12	18	11	41
47	Herschel Rd/Old National Hwy	10	29	11	50
48	Riverdale Rd	10	10	10	30
49	I-75 (north)	17	39	16	72
50	Upper Riverdale/Old Dixie/Browns Mill Rd	11	21	11	43
51	Marietta Blvd/Cooper Lake Rd	10	22	9	41
52	Mount Vernon Rd/Spalding Rd	11	19	10	40
53	Johnson Ferry/Childers/Jones Rd	9	25	10	44
54	Barrett Pkwy/Post Oak/Tritt/Willeo Rd	12	23	10	45
55	Shallowford Rd/Pine Rd	11	24	8	43
56	Windy Hill/Terrell Mill/Old Canton/Holly Spr	6	23	12	41
57	Dallas Rd/Whitlock/Roswell/ Paper Mill Rd	7	14	5	26
58	Old Alabama/Jones Bridge/McFarland Rd	6	19	10	35
59	Lawrenceville-Suwanee/Suwanee Dam Rd	11	21	11	43
60	Old Norcross Rd	8	13	15	36
61	Killian Hill/Indian Trail/Bethany Church Rd	15	16	12	43
62	Rockbridge Rd/Rockbridge Dr	9	38	18	65
63	Wesley Chapel/Flakes Mill/Fairview Rd	11	10	12	33
	Grand Totals	736	1,339	742	2,817

In addition, drivers needed to check into PBS&J's office every one or two days to exchange data recorders. This required additional driving time and mileage that did not contribute toward the sample size but was necessary to execute the data collection using the GeoLogger GPS technology. Moreover, drivers needed to make long commutes to reach the beginning or end points of some routes on some days.

The general pattern exhibited by the mileage figures is not unexpected. The PM peak period contains the fewest number of miles, approximately 9,542. This is perhaps attributable to the fact that the worst congestion occurs during the PM peak period. For this reason, drivers were able to complete fewer sample runs on each route. The AM peak period contains only slightly more mileage, 10,624 miles, than the PM. This appears to be a result of less congestion in the morning, especially in the off-peak direction of travel. A total of 17,982 miles were logged collecting samples for the Off-peak period. Off-peak was the longest time period, lasting 6.5 hours from 9:30 AM to 4:00 PM. As such, it was not surprising this time period contained the highest amount of mileage in the sample runs.

3.4 Issues

Some issues did arise during data collection activities. Most, but not all, were related to difficulties with the drivers or the condition of their cars. On the first full day of data collection, September 11, 2001, the United States was attacked by international terrorists. Because of this, many businesses in the Atlanta area closed operations for at least a day. Throughout the rest of the week traffic patterns on many routes in Atlanta were not normal. One route (Route 19 – South Cobb Drive) lies directly adjacent to Dobbins Air Force Base. The driver on this route was pulled over and questioned by law enforcement officials several times as part of the United States military's high level of alert that week. Supplemental data collection was performed in later weeks on that route and all others driven during the week.of 911.

There was difficulty maintaining some of the drivers' level of commitment. There were occasions when drivers did not show up on time to their assigned route or did not show up at all. As much as possible, these drivers were replaced but this caused inefficient use of equipment and additional attention to the supervision of drivers that was not anticipated. Another problem occurred when drivers drove the wrong route for an entire day because of lack of familiarity with the area (some drivers were new to the Atlanta area), or they would pull off the route in the middle of a sample run for brief gas/beverage stops. It was stressed to them numerous times the importance of staying on the route, but nevertheless this did occur. As a result of these problems, much more time was spent re-running samples that contained bad data and assigning drivers to obtain route samples for missing time periods on various routes. As a result, the average number of routes completely sampled during a typical week was closer to 10 or 11 as opposed to 19 which would be possible under ideal conditions.

The shear amount of driving done by temporary employees in their autos or rental cars was enormous. It was not uncommon for one or two drivers on a given weekday to excuse themselves from work due to mechanical problems. Common mechanical problems included tire blowouts, heating/cooling problems or brake problems. Drivers were compensated for mileage at a $0.345 cent per mile rate. PBS&J used driver log sheets to compensate new drivers who could follow directions as soon as possible so that they could attend to car repairs and return to work as soon as possible .

4.0 Preliminary Analyses

Preliminary summaries of the travel time and speed data by route are reported in this section along with segment-level summaries stratified by facility type and area type. Maps depicting the exact routes that were driven during data collection are displayed in Appendix A. Route maps also include annotation showing the delineation of each segment used in developing average speed statistics by facility type and area type. A plot map and route-level sample summary report were prepared for each route. The report consists of group statistics pertaining to each individual route. Group statistics were computed from the entire sample set for a given route, time period and direction of travel. The statistics include: sample count, average time, standard deviation of the average time and average speed.

A segment-level summary of average speeds is presented in this section by facility type and area type code combinations. These average speeds were calculated using all of the segment observations, from all routes and during all time periods. Three more segment-level summaries, by facility type and area type, are included in Appendix B which display average speeds for the AM, PM and Off-peak time periods.

The fundamental unit of data collection in this study was route-level driver samples. Each of the 2,817 samples is identified by route number and summarized in terms of travel time and average speed in a separate document containing a supplemental technical appendix to this technical memorandum.

4.1 Route-Level Statistics

Route-level data is displayed and summarized in Appendix A. This data consists of a massive quantity of information that was collected, processed and screened prior to computing group-level route statistics or segment-level calculations of average speed by facility type and area type. A total of 63 tables are contained in Appendix A, one for each route. They contain group-level summary statistics by time period and direction of travel. A number of sample runs were removed from the calculations of group-level route and segment-level statistics. They are listed in a table in Appendix C.

There were several generic patterns depicted in the group-level route statistic tables that one would suspect from a study of this nature. On radial routes that carry motorists between suburban areas and major activity centers such as downtown and midtown Atlanta, the general trend of travel in the AM peak period is that of slower travel times and speeds in the inbound directions of travel. In the PM peak period, the slower speeds occur in the outbound direction of travel. For example, the routes on the north side of Atlanta that direct travel into and out of the city have significantly slower speeds in the southbound direction during the morning peak. Similarly, the outbound direction of travel in the PM peak period is slower due to return commutes. In addition, inbound speeds are relatively slow during the PM peak period because of afternoon traffic volumes in the off-peak direction of travel that are higher than their AM peak counterparts. In the Off-peak period, the average speed is almost identical in each direction, and generally reflects the free-flow conditions of an uncongested road.

Routes that carry cross-town traffic on non-radial routes generally do not display as much difference in travel time and speed by direction of travel during the peak periods. This is due to the fact that there is not a distinguishable direction of commuter travel in each peak period. However, overall speeds may be slightly lower due to relatively equal commuting in both directions.

4.2 Segment-Level Statistics

After screening the route-level samples for outliar speeds by route, time period and direction of travel, segment-level statistics were calculated to obtain average speeds by area type and facility type. The segments were established in the sample design of the study by partitioning routes into relatively short sections that could be tagged with an area type and facility type code from the ARC's base year (2000) highway network file. A total of 1,016 unique segments, slightly more than 16 per route, were defined which produced more than 38,000 useable segment observations from the route data sets. Segment lengths ranged from 0.1 to 3.0 miles in length. Each of these sample segments is shown by means of points and annotation on the plot maps for each route that were included with the tables in Appendix A.

The average speed by area type and facility type analysis was performed using cross-tabulations of the segment data by facility type, area type and time period. This data is broken down by AM peak, PM peak, and Off-peak periods, as well as statistics for the entire data set (All three time periods combined). For each time period there are three tables: the first is the sample segment size (frequency), the second is the un-weighted average speed, and the third is the standard deviation of average speeds. The set of three tables representing all time periods combined is shown on the next page. The other sets, for the AM, PM, and Off-peak time periods, are presented in Appendix B.

The un-weighted average speed table is not unlike a look-up table that would be used in a travel demand model. Most patterns found in these tables are not unexpected. Specifically, as the area types change from Urban High-Density (HD) to Rural the speeds generally increase. Urban areas exhibit slower speeds because of more congestion caused by more driveways, traffic signals, pedestrians, narrower streets, decreased sight distance, and generally higher traffic volumes. This trend can be seen in all the average speed tables in the average speed table shown on the next page as well as in those for each time period in Appendix B.

Similarly, as facility type or function changes, from Freeway to Collector facilities, the speeds decrease. Freeway designs facilitate fewer delays and stoppages while the Collector street usually contains frequent intersection spacing, narrower travel lanes, traffic control devices, and lots of turning motorists. Again, this trend can be seen in the average speed tables.

Average Speed Tables (6:30 AM to 7:00 PM)
By Facility Type and Area Type

Sample Segment Size Facility Type and Area Type

Facility Type	Urban Commercial HD	Urban Commercial Comm.	Urban Residential. HD	Urban Residential	Suburban Commercial.	Suburban Residential	Rural	Row Totals
Freeway	420	1,266	665	2,203	1,963	1,871	725	9,113
Class I	367	414	687	1,512	1,152	1,037	579	5,748
Class II	291	508	914	2,875	2,826	1,887	1,218	10,519
Class III	0	68	337	2,295	1,513	3,270	3,521	11,004
Collector	0	21	18	254	330	447	853	1,923
Col. Totals	1,078	2,277	2,621	9,139	7,784	8,512	6,896	38,307

Unweighted Average Speed By Facility Type and Area Type

Facility Type	Urban Commercial HD	Urban Commercial Comm.	Urban Residential. HD	Urban Residential	Suburban Commercial.	Suburban Residential	Rural	Row Totals
Freeway	68.3	68.4	74.8	67.0	68.8	71.8	72.9	70.3
Class I	25.4	27.8	29.5	30.7	31.3	39.4	47.8	33.1
Class II	28.6	27.4	30.2	33.4	31.0	35.4	42.1	32.6
Class III	-NA-	28.1	26.6	33.1	30.8	33.6	42.7	32.5
Collector	-NA-	26.1	17.7	25.0	28.8	33.0	37.0	27.9
Col. Totals	40.8	35.5	35.7	37.9	38.1	42.6	48.5	-NA-

-NA- denotes that the statistic is not appropriate

Standard Deviation of Average Speed By Facility Type and Area Type

Facility Type	Urban Commercial HD	Urban Commercial Comm.	Urban Residential. HD	Urban Residential	Suburban Commercial.	Suburban Residential	Rural
Freeway	15.3	14.8	14.5	16.0	13.4	12.7	11.7
Class I	12.4	12.1	12.4	12.6	11.1	12.7	14.6
Class II	12.0	12.7	12.6	12.5	12.1	14.2	13.9
Class III	-NA-	10.6	13.7	11.2	11.1	10.8	10.9
Collector	-NA-	7.1	5.3	10.4	10.6	11.7	12.4

-NA- denotes that the statistic is not appropriate

5.0 Appendices (Route Maps and Statistics)

Appendix A

This section contains route maps, segment definitions and two route-level reports summarizing the data that was collected in this study. The maps and report information are presented sequentially by Route ID number.

Appendix B

This section contains tables for segment-level statistics, cross-tabulated by area type and facility type. There are three sets of tables found in the following order: AM Peak period, Off-peak period, and PM Peak period.

Appendix C

This section contains a list of route samples that were removed from the analysis data set prior to performing the grouped route and segment calculations for average speed.